Opening Remarks

by

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I am very pleased to welcome you to the 2003 Nuclear Safety Research Conference. I see many familiar faces in the audience, and many new attendees, as well. We have put together a program for this year's conference that I think you will find very interesting, covering a range of topics representative of the challenges that the NRC is currently facing and expects to confront over the next several years. Before I turn the microphone over to Chairman Diaz for his keynote address, I would like to make a few remarks about some of the objectives of the conference.

As many of you are aware, we have been striving over the last several years to find ways to make this conference more useful and meaningful to the audience. The change in name from Water Reactor Safety Information Meeting to Nuclear Safety Research Conference is representative of this effort. It is not just cosmetic, but is meant to convey the larger set of issues and challenges that the NRC–in fact, the nuclear industry in general–is now facing; not only water reactor safety, but issues related to advanced, non-light-water-cooled designs, as well as materials and waste disposition. We have also tried to find ways in which to increase and enrich the technical content of the conference. In that respect, we are introducing this year poster papers on a variety of topics, including systems codes, fire modeling, reactivity insertion accidents, and the Package Performance Study for spent fuel transportation casks. The poster papers will be available in sessions throughout the conference, and are intended to provide you with the opportunity to review the technical information and issues, and to discuss them with the authors, possibly in more depth than would be possible in a formal paper presentation or panel session. Of course, we continue to offer those traditional technical session formats, as well.

I am pleased to note that we will hear during the conference from all of the current members of the Commission, with the Chairman leading off this morning, Commissioner Merrifield on Tuesday, and Commissioner McGaffigan on Wednesday. The technical program reflects the dynamic environment in which we operate; we are challenged with maintaining a focus on safety in a range of areas such as aging, license renewal, power uprates, and new designs. We have included panel sessions on realistic conservatism and risk-informed regulation, materials degradation, and on knowledge management, a new topic dealing with the problems of collecting, preserving, and transferring the huge amounts of information that we generate in our research programs. We'll also have technical sessions on risk-informed regulation, decommissioning, operating experience, advanced reactor concepts, spent fuel behavior, high-burnup fuel, and materials degradation. I'd like to take just a few minutes and discuss two of these topics that are of particular importance.

As most of you are aware, the NRC has been engaged in an effort to make both our regulations and our regulatory processes risk-informed and, where possible, performance-based. The basis for our work in this area is a White Paper that was issued by the Commission in 1999, which defines the terms "risk-informed" and "performance-based" and their relationship to other elements of the NRC's regulatory philosophy–particularly defense in depth, and explains the NRC's approach for implementing this regulatory paradigm. We have been making steady

progress in risk-informing various aspects of our rules and activities–for example, we have guidance available for risk-informed license amendments and risk-informed in-service inspection programs, and we have published a risk-informed alternative for the control of combustible gases in containment. In addition, Chairman Diaz has, within the last several months, introduced a related concept, "realistic conservatism," to the NRC's approach to regulation. He will be discussing this in his remarks in a few minutes, but let me just say that this is a natural and logical progression that recognizes the advances in our knowledge about the behavior of the systems with which we and our licensees deal, based on both operating experience and the insights that have been developed from our research programs. Using this knowledge base, it should be possible to anchor our regulatory approach in "real world" physics–a realistic evaluation of potential safety issues–and ensure that adequate safety margins, which are a measure of conservatism, are provided to maintain an acceptably low risk to public health and safety from our licensed activities.

I would also like to say a few words about our approach to materials degradation issues, about which you will hear more discussion on Wednesday. This has been one of the most prominent topics with which we have been engaged over the last few years–in fact, we recently held a major meeting on just that subject. While recent interest has been driven in large part by the experience at Davis-Besse, it is important to note that the NRC's programs dealing with materials degradation go back more than 30 years. We recognized in the early days of the nuclear industry that there were significant challenges to the materials and components in nuclear power plants. As some early concerns were studied and resolved, new ones have continued to arise. And with the advent of license renewal and the prospect of plant operation for up to 60 years, materials degradation will assuredly continue to be an issue of substantial importance. The NRC's approach is therefore designed to be proactive, seeking to anticipate and manage age-related degradation before significant safety challenges arise. There are three major aspects to this effort. First, licensee programs to manage degradation are reviewed and, if necessary, specific actions may be mandated. Research provides data and analysis tools to evaluate licensee programs and support regulatory actions. The second element is a multi-faceted strategy to evaluate the expected performance of new materials, assess new inspections procedures and techniques, and identify, through testing and analysis, potential new degradation mechanisms. The final element is continued monitoring through the research program of repair and mitigation strategies proposed by the industry, including confirmatory assessments addressing the effectiveness of those strategies and their potential for introducing unanticipated problems. I trust you will find these discussions interesting.

Finally, I would like to acknowledge the broad participation that has been a hallmark of this conference over the years. In addition to over 100 NRC staff members, we have more than 200 non-NRC attendees joining us this year, representing 20 different countries. I hope you will take the opportunity this conference affords to meet your colleagues from both inside and outside the NRC, and to discuss many subjects of mutual interest.

I would now like to introduce our keynote speaker for the morning. Dr. Nils Diaz was designated by the President as Chairman of the Nuclear Regulatory Commission in April of this year, upon the departure of former-Chairman Meserve. Chairman Diaz was first appointed as a Commissioner in 1996, and was reappointed and reconfirmed for a second term in 2001. Prior to becoming a member of the Commission, he was a professor of nuclear engineering sciences at the University of Florida, where he also served as director of the Innovative Nuclear Space Power Institute. He holds a bachelor's degree in mechanical engineering and master's and doctoral degrees in nuclear

engineering, and was also a licensed senior reactor operator. Chairman Diaz has been named a Fellow of the American Nuclear Society, the American Society of Mechanical Engineers, and the American Association for the Advancement of Science. As most of you are aware, Chairman Diaz has been a strong advocate for risk-informed and performance based regulation as a means of ensuring a strong safety focus in the NRC's regulatory activities. This morning, he will address the subject of Realistic Conservatism.

Chairman Diaz.

Remarks by Chairman Diaz at the
2003 Nuclear Safety Research Conference
October 20, 2003

Realism and Conservatism

Introduction

I am pleased to welcome you as the NRC convenes the 2003 Nuclear Safety Research Conference (NSRC). This is one of the oldest continuing conferences devoted to nuclear safety and research, having begun as the Water Reactor Safety Information Meeting in 1973, with a focus on regulatory issues. Today I would like to discuss with you the concepts of "Realism and Conservatism", and how these concepts relate to the NRC research activities and regulatory decision-making. I believe that the use of state-of-the-art know-how, anchored in research, plays a vital role in how realism and conservatism are used by regulators. Some may argue it is actually Realism vs. Conservatism because they are competing forces, that one is applied at the expense of the other. I could not disagree more; we are capable of dealing with both in a constructive manner.

The landscape of nuclear power has changed significantly over the past 30 years: the number of operating nuclear power plants has roughly quadrupled in both the United States and the world as a whole, and nuclear energy now provides one-sixth of the world's electric power. In that span of time, technological know-how has exploded; we know better. The NRC's research program has evolved as well, moving beyond light-water reactor safety issues to a broader safety landscape that includes materials and waste safety issues. Regardless of the changes in the nuclear industry, in the NRC research programs and in the NRC in general, the drive to ensure adequate protection of the public health and safety while licensing and overseeing the safe operation of nuclear plants has been unwavering.

We are now experiencing a very dynamic period. Operating experience and safety performance have demonstrated the safety and reliability of nuclear power. For the first time in many years, economic, political, and environmental conditions may make a renaissance of nuclear power possible. Life is full of surprises but surprises are not needed in our dynamic world. Through this period of change, vigilance on safety is and will remain at the forefront of our minds.

Now I would like to explore the role of Realism and Conservatism in research, and its importance in regulatory decision-making.

Realism and Conservatism

For purposes of simplicity, I will be using "conservatism" in the sense of preserving adequate safety margins, and I am using "realistic" in the sense of being anchored in the real world of physics, technology and experience. Let me now turn to what I mean

by “realistic conservatism”: it combines the essence of the above mentioned definitions, and uses prudence and hard-headed common sense, firmly grounded in real-world conditions, coupled to a commitment to make informed decisions and move on. The consistent implementation of these sets of conditions and outcomes is not easy; nevertheless, it is what is demanded from a nuclear regulatory agency in 2003. Neither under-regulation nor over-regulation serves anyone’s interests. Under-regulation puts the public safety at risk; over-regulation diminishes the value to society of the regulated activity. Over-regulation could also be counter-productive to safety by diverting resources from the important safety issues.

Let me explain how the concept of conservative realism can be applied to research and decision-making. I have often said that "public policy should not be based on worst case scenarios" and that "we have to deal with probabilities and not with all possibilities." So called worst case scenarios are only good as vehicles to achieve the proper bounding of realistic scenarios early in the process. Nuclear policies and regulations are necessarily conservative, but should not be driven by non-physical or unrealistic assumptions. Worst case assumptions are often considered as a first step and are used because they are simple. But, the unfortunate consequences of using worst case assumptions is that they often continue to propagate and eventually become part of the established framework. And, frankly, no one wants to appear as “non-conservative,” or “less conservative”; it is always easier to add to conservatism than to bring realism. But realism is what could be in the best interest of the public well-being. Rather than using worst case scenarios, we should be using realistic conservatism --- based on the right science, engineering and technology --- so that the end product is recognizable and useable. I believe we should avoid the "worst case" syndrome .... and seek out "realistic conservatism."

For many of today’s regulatory research endeavors, it is necessary to consider the probability of a scenario before undertaking the consequence calculations. The calculation of disastrous results for highly improbable events helps no one, wastes resources and frequently results in unnecessary public fear. Sprinkling unrealistic conservatisms, even if they are small but compounding conservatisms, throughout an analysis or study can skew the results significantly. They do add up, or even multiply. How can a safety-conscious decision maker, in the broadest sense of the term, use a study that is filled with unrealistic assumptions? Who pays for unnecessary conservatism? Society does. The real value of conservatism is not at the beginning or in the assumptions or the boundary conditions. It is at the end, when the decision is made; at that point, we need to know the safety worth of the conservatism. Research and analysis should be conducted as realistically as possible using the best information available. Uncertainties should be understood to the greatest extent practicable, quantified and considered appropriately in the decision process. This is especially important when approximations are made; if not, they could remain hidden under the mantle of conservatism.

To illustrate the way this approach can work, I'd like to use an example with which most of you are familiar: the development of probabilistic risk assessment and, concurrently, the NRC's major efforts in thermal-hydraulics, particularly in the area of loss-of-coolant accident analysis.

In the early days of nuclear power, it was relatively easy to determine that there were some gaps in our knowledge. What was much more difficult was determining the safety significance of the technical areas in which our knowledge was insufficient. The consequences of these factors can be seen in the NRC's early regulations. A case in point is the ECCS Rule, 10 CFR 50.46, and the associated Appendix K to Part 50. An extremely conservative approach was taken in evaluating a plant's response to a hypothetical large-break loss-of-coolant accident. The postulated break was a "worst-case" scenario -- a double-ended guillotine rupture that occurred instantaneously. We all know that this is not actually the worst case, nor what we should defend against, however, it was chosen because it was sufficiently draconian. In hindsight, the conservatism was lacking realism. The analysis methodology prescribed by Appendix K included thermal-hydraulic models and assumptions that were known to greatly over-predict the loss of reactor coolant and under-predict the performance of core cooling systems, leading to artificially high cladding temperatures, and thus to large safety-margins. The overall result was recognized to provide substantial safety margins for a LOCA. Moreover, the acceptance criteria in 10 CFR 50.46 were established to provide another significant layer of margin to core damage, even if the calculation of cladding temperatures had been reasonably accurate. The ultimate result of our early lack of fundamental knowledge was layer upon layer of conservative margin. The effects of this conservative approach are strict operational restrictions and a disproportionate amount of focus on an accident that - in reality - has very little likelihood of occurring. We were not being "realistically conservative." I have said in the past that ignorance could choose to hide behind conservatism; we all realize this is not acceptable.

The NRC has changed the way it regulates, for the better, with an increased focus on the issues that are really important to safety. Consistent with this approach, NRC has undertaken research programs with the objectives of increasing our fundamental understanding of LOCA behavior and determining the actual safety significance of LOCAs themselves. These programs included major experimental and analytical efforts, gathering separate-effects and integral-systems data on LOCA thermal-hydraulics and using them to develop sophisticated mathematical models to calculate more realistically the behavior of a reactor during such an event.

The issue of safety significance of LOCAs is getting old, it was investigated as part of the landmark Reactor Safety Study, published as WASH-1400. That study pioneered the use of a quantitative, probabilistic approach to estimate the likelihood of reactor accidents and their consequences. You may recall that one of the conclusions of WASH-1400 was that large-break LOCAs posed a much smaller risk than had been assumed previously, but that small-break LOCAs were of greater risk significance. This

research helped the NRC to understand the areas in which there were still substantial uncertainties, and also provided a basis for focusing further research on issues of high risk significance. Continued development of PRA techniques -- and expansion of the database for PRA analyses as more reactors were built and operating experience increased -- helped to reduce the initial large uncertainties in early risk analyses.

As both industry efforts and NRC research results chipped away at both PRA and thermal-hydraulic uncertainties, alternative methodologies became acceptable, as well as best-estimate techniques for LOCA analysis. Over the last few years, however, the accumulation of knowledge concerning both the likelihood of large pipe breaks and the phenomena governing the plant's response to such events has permitted the NRC to come to the realization that the regulations governing the consideration of LOCAs within the design bases of a plant can and should be improved. Consequently, earlier this year, the Commission directed the staff to develop modifications to our rules that will incorporate the option of a risk-informed and performance-based approach in 10 CFR 50.46 and related regulations. You will be hearing more about this effort later in the conference. For now, let me simply note that the above noted step-wise increases in the technical base is demonstrative of the value of safety research for making sound regulatory decisions. At times, it appears it takes too long to achieve closure, however, I am encouraged that we are moving faster now in the right direction.

It is my expectation that, when modified, the regulations will be an example of realistic conservatism in action: the selection of the appropriate design-basis LOCA will be supported by a process that is scientifically sound and based on realistic models of both risk and system behavior, and the acceptance criteria for emergency core cooling system performance will be established to provide a level of conservatism that accounts for uncertainties that may still exist. That conservatism -- or safety margin, if you prefer -- will provide the reasonable assurance of adequate protection of public health and safety. However, it will be established on the basis of what we currently know as a result of both operating experience and extensive research, rather than what we knew or did not know in the early 1970s. The larger and less likely LOCAs will still be addressed, but in severe accident space like many other highly unlikely scenarios.

There are many other examples of successes in reducing unnecessary conservatism by research. For example, the development of a new realistic source term, which was put in place several years ago as an alternative to the highly conservative version, was based on appropriately focused research. This research helped support NRC decisions on numerous license amendments that allowed reductions in regulatory burden without compromising safety margins. Some of these amendments have resulted in reduced occupational exposures and greater operational flexibility. Although, these benefits may seem modest, I would like to reiterate that they have occurred without compromising safety margins. The source term research also contributed to our advance reactor reviews and it continues to be used by the NRC when conducting analyses to realistically evaluate dose consequences and health effects for a broad set of scenarios.

In the waste arena, the NRC's research program on Radionuclide Transport in the Environment has as a principal objective the development of more realistic and defensible estimates of exposure of the public to radiation from radionuclides released from contaminated sites or waste disposal facilities. The models developed in this program and the regulatory guidance that evolves from them will be important elements in the NRC's oversight of waste disposal activities. Although we have had successes, we certainly have a long way to go. It is my expectation that our research efforts will put us in a better position to make realistically conservative regulatory decisions in the future.

At last year's NSRC I presented my thoughts on realistic conservatism, and also talked about when we should consider research activities adequate for their intended purpose. This conference, which brings together nuclear experts from all over the country and the world, is a good opportunity to revisit the last issue. I will revisit it by asking a few pointed questions. -- Are we analyzing the right things? - Are the results useful, from a scientific, technological and regulatory perspective? Are questions and answers fitting the present and future needs, and are they adequate? These issues require resolution, day in and day out.

There is no doubt that NRC research should always be conducted with the intent of putting the agency in a position to make sound regulatory decisions that are beneficial to ensuring adequate protection of public health and safety. The decision that the agency faces should be kept in mind as the research is planned, conducted, completed and communicated. It is essential to understand what we know, what we don't know, and what we need to know in order to adequately address issues of safety significance. Let me emphasize the word "adequately." We do not necessarily need to know everything or as much as possible about an issue. We need enough to <u>adequately</u> address the issue. The research the NRC engages in should be undertaken with the objective of preparing the agency for today, tomorrow, and future regulatory and safety decisions and challenges.

A point in question. We have been making regulatory decisions regarding security, terrorism and physical protection for many years. Since September 11, 2001, these decisions have been more challenging and it is clear that we will continue to make regulatory decisions in these areas. Today the Nation is asking us to evaluate the potential for vulnerabilities that may or may not exist as a result of terrorist threats and identify possible mitigation strategies. These assessments, which are pushing the state-of-the-art in many areas, demand the highest quality work and a pragmatic approach to problem-solving, with a demanding schedule and resource limitations. The quality of many of our future regulatory decisions in this area will be based, in part, on these assessments, and in this case, there is not doubt that realism is the only show in town.

Conclusion

My objective this morning has been to discuss how we can maximize the value to society of our efforts, using realistic conservatism to focus research and decision-making. I believe that the goal of moving toward a more realistic basis for regulatory decision-making goes hand-in-hand with the NRC's policy of implementing a risk-informed and performance-based approach to regulation. In fact, the two are inextricably linked, since one cannot determine the risk significance of an issue without a realistic understanding of it.

The work of the NRC is, in microcosm, a reflection of the work of the nation as a whole. There are competing interests and different points of view, strongly held, but what unites us is far greater than what divides us. All of us -- the NRC, its licensees, the public, stakeholders of all kinds -- have a common interest in public safety and security, and the well-being of our nations. All of us have different perspectives and insights to contribute; at its best, democracy permits a synthesis, in which we glean the best from divergent viewpoints and apply them to our common purposes. The public, whose health and safety we protect, have to be the beneficiaries of our research and our decisions; therefore, we need to focus our efforts, with confidence, anchored on technical competence, on issues that have the greatest impact on safety. To prepare the agency to meet the challenges facing us in the future, I believe we should strive for a strong, safety-focused, decision-driven research effort supporting the application of realistic conservatism and state-of-the-art know-how to carry-out our mission, while acknowledging the existence of uncertainties that are well-understood and characterized. One last word about realism and how it plays on the well-traveled paths, the paths being carved, and those not yet even surveyed. This aspect of realism is tied to completeness and depends heavily on both scientific and system engineering expertise.

In words made popular by Robert Kennedy, "Some men see things as they are and say 'why?' I dream of things that never were and say 'why not?'"

I wish you health and a great conference. Thank you.

Risk-Informed Regulation Realistic Conservatism

Mario Bonaca
Chairman
Advisory Committee on Reactor Safeguards (ACRS)

Nuclear Safety Research Conference
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Importance of Uncertainties in Decision-Making Process

- **Both deterministic and probabilistic safety evaluations must deal with uncertainties**
- **The assessment of PRA uncertainties should address model uncertainties. Such uncertainties can be very large and may affect the relevant decision-making process**
- **While simple applications under RG 1.174 may not require a full evaluation of uncertainties, further progress in more complex applications will need consideration of all uncertainties**
- **Guidance is needed on how uncertainties should be treated in the PRA and how they impact decision-making process**

Challenges with Risk-Informed Approaches in Regulatory Applications

- Inherent difficulty in risk-informing within a deterministic environment
  - Lack of consistency between accident sequences considered
  - Different approaches to treatment of uncertainties
  - Lack of a consistent definition of risk
- Inherent complexity of reducing "unnecessary conservatism" in the face of state-of-knowledge uncertainty
  - Need to preserve necessary defense-in-depth measures

Consistent Consideration of Realistic Conservatism

- Guidance should be developed for consistent definition and consideration of realistic conservatism criteria or guidelines
- At this time, qualitative guidance seems more appropriate than criteria or guidelines
- Can we consider realistic conservatism without a better appreciation of all uncertainties?

Scope and Quality of PRA for Regulatory Applications

- **Insights from NUREG/CR-6813,"Issues and Recommendations for Advancement of PRA Technology in Risk-Informed Decision-Making"**
  - **Improving the scope and quality of the PRAs is very important to the advancement of risk-Informed regulation**
  - **Some applications can be supported by limited scope PRAs, but significant NRC and licensee resources must be expended to justify the use of a limited model**
  - **Use of bounding analyses, to account for the missing PRA elements, do not necessarily lead to conservative decisions**
- **Risk-informed applications rely on baseline values of CDF and LERF**

Scope and Quality of PRA for Regulatory Applications (Cont'd)

- We need to continue to build experience with the current process, relying on the existing PRAs, but
- We also need to see continuing improvements in PRA quality and scope to help us move toward a more effective and efficient risk-informed regulatory framework
- The implementation of more complex risk-informed rules, such as the one being developed for 10CFR50.46, will require complete PRAs, or at least PRAs of sufficient scope and quality that can address all issues relevant to the specific regulatory application

NRC Nuclear Safety Research Conference

Risk-Informed Initiatives and Realistic Conservatism

Tony Pietrangelo
Senior Director, Risk Regulation
October 20, 2003

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Realistic Conservatism

- Ensure that the results of analyses are physically possible, have a credible likelihood, and do not distort the overall focus on safety
- Concern that use of bounding/conservative techniques whenever and wherever possible yield results that are excessively conservative
- Need for more integrated treatment of conservatism

Example – PWR Sumps

- One Analysis Element - Debris Generation
  - Break size
    - Spectrum consistent with 50.46
  - Break location
    - Potential debris sources
    - Proximity to sump
  - Break characteristics
    - Most debris
    - Exactly provides “thin bed” effect
- Which combination is the most limiting?
  - No consideration of frequency or credibility

Consideration of Uncertainties

- Current risk-informed decision-making framework (RG 1.174) was formulated to address concern with an integrated process
  - Defense-in-depth
  - Safety margins
  - Performance monitoring
  - “Small” increases in risk
  - Conservative acceptance guidelines
  - Expert panel review

Challenges for Risk-Informed Approaches

- State of knowledge is what it is
- Issues like organizational factors and security are not yet amenable to quantitative insights
  - May consider qualitatively, but unlikely to change decision
- Don't oversell risk-informed approaches
  - Don't use non-quantifiable concerns as excuses to stand still

Consistent Consideration of Realistic Conservatism

- Would be useful to develop some criteria or guidance for use in all regulatory approaches
- Goal would be to ensure that the cumulative effect of adding conservatism results in something credible and sensible

Need for Full-Scope, All-Mode PRA?

- Industry Position
  - Industry supports full scope, all modes risk assessment
  - Use quantitative models when available
  - Use bounding or screening analyses for elements not modeled
    - Designed to maintain low risk

Use of Risk Information in the Reactor Oversight Program (ROP)

Loren R. Plisco

Deputy Regional Administrator

USNRC/Region II

Outline

- What are the program goals?
- How are we using risk information?
- What is working?
- What has been challenging?
- Summary

NRC's Strategic Plan Performance Goals

- Maintain safety, protection of the environment, and the common defense and security
- Increase public confidence
- Make NRC activities more effective, efficient and realistic
- Reduce unnecessary regulatory burden on stakeholders

ROP Characteristics

- **Objective: Subjective decisions and judgment were not central process features**
- **Predictable: Stakeholders know regulatory response to issues and indicators**
- **Scrutable: Be able to understand NRC actions in response to licensee performance**
- **Risk-informed: NRC and licensee resources are focused on those aspects of performance having the greatest impact on safe plant operation using risk.**

How Are We Using Risk Information?

- Inspection program structure
- Inspection planning/sample selection
- Evaluation of inspection findings (SDP)
- Incident Investigation/Event response
- Enforcement Discretion
- Evaluation of emergent issues/conditions

What Is Working?

- Inspections focused on important activities
- Findings are important safety issues
- Inspectors are learning what is most important at each site
- Event response more predictable and measured
- We are inspecting and talking about the right things

What Has Been Challenging?

- Compliance vs. Risk-Informed
- Quality of risk information/tools
- Simple tools vs. risk expertise
- Communicating with public/transparent
- Timeliness vs. accuracy
- Accounting for uncertainties/assumptions

Summary

- Reactor oversight process, which brought risk into our day-to-day inspection activities, is a big improvement – we don't want to go back.
- Difficulties remain to be overcome to keep moving forward – but we think we have them identified and they are being worked.